Space Weather Technical Forecast

Issued on Thursday, 30 March 2023 at 00:14 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance G1/Minor Storming from late day 1 (30th) until day 3 (1st April). Active electron fluence expected to continue into day 1 (30th) and possibly day 2 (31st). Chance of isolated Moderate flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has reached High levels over the past 24 hours, following an X1.2 flare at 29/0233UTC, an M1.8 flare at 29/1406 UTC and a M1.1 flare at 29/2346 UTC all from AR3256.

There are currently seven numbered and five unnumbered sunspot regions on the visible disc. AR3256 in the southwest remains the largest and most magnetically complex region, although showing continued signs of decay in its trailer portion. The other active regions appear stable and magnetically simple, with only minor fluctuations in areal extent. No Earth-directed CMEs currently feature in the forecast.

Solar Wind / Geomagnetic Activity: The solar wind, as measured at L1 by ACE, was mostly at background to slightly elevated levels, with speeds ranging between 350-430km/s. Density was below average, on a slight increasing trend. The IMF (Bt) was mostly weak between 6-9nT, with the north-south component (Bz) also weak, varying between +5/-6nT. The net result of the above solar wind measures was for mostly Quiet (Kp 0-2) geomagnetic activity.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at Background levels.

The high energy electron flux (greater than 2MeV) measured at GOES16 rose from Moderate to mostly High levels, with a peak of 3870 pfu observed at 29/1255 UTC. The associated 24-hour fluence has continued to rise, and has been above the Active (1e8 integrated pfu) threshold since 29/0900 UTC. At 30/0001 UTC the observed fluence was 1.81e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be predominantly Low, but with a Chance of further isolated M-class flares, most likely from AR3256 in the southwest.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast. The next coronal hole expected to impact Earth is CH88/-. The HSS and CIR from this feature may arrive from late on day 1 (30th), lasting until day 3 (1st), with speeds likely to reach up to 500-550km/s. Solar wind speeds will then likely return back to slightly elevated or slow-ambient by day 4 (2nd).

Geomagnetic activity is expected to be mainly Quiet (Kp 0-2) initially, rising to Unsettled (Kp 3) with Active (Kp 4) intervals and a chance of G1/Minor or G2/Moderate storms upon the arrival of the HSS of CH88/- from later on day 1 (30th March), lasting until day 3 (1st April). Geomagnetic activity will likely return back to Quiet to Unsettled (Kp 0-3) later on day 3 or by day 4 (April 1st-2nd).

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to remain at Background levels, but with a Slight Chance of reaching S1 or greater,

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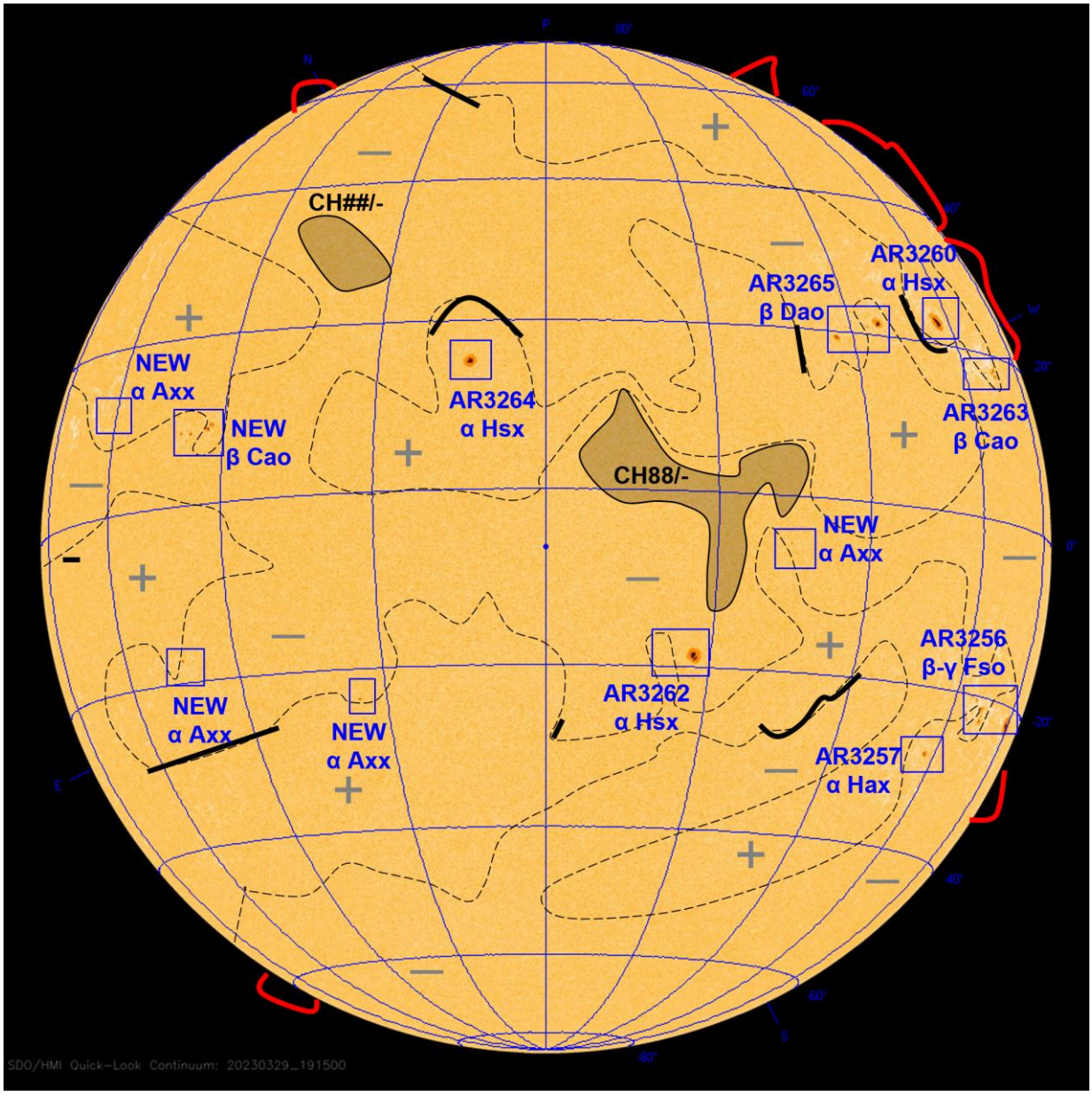
should any significant flares occur.

The high energy (greater than 2 MeV) electron flux likely to continue at moderate to high levels through days 1 and possibly early day 2 (30th and 31st). The anticipated HSS arrival from CH88/- is then likely to re-distribute electrons, with a reduction in electron flux levels expected. The 24-hour integrated electron fluence is expected to continue at Active levels through day 1 (30th) and perhaps into early day 2 (31st). This should then reduce into day 2 until day 4 (March 31st until 2nd April) as Earth enters the High Speed Stream (HSS) from CH88/-.

Figure 1. Solar Analysis Valid 29/1915 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

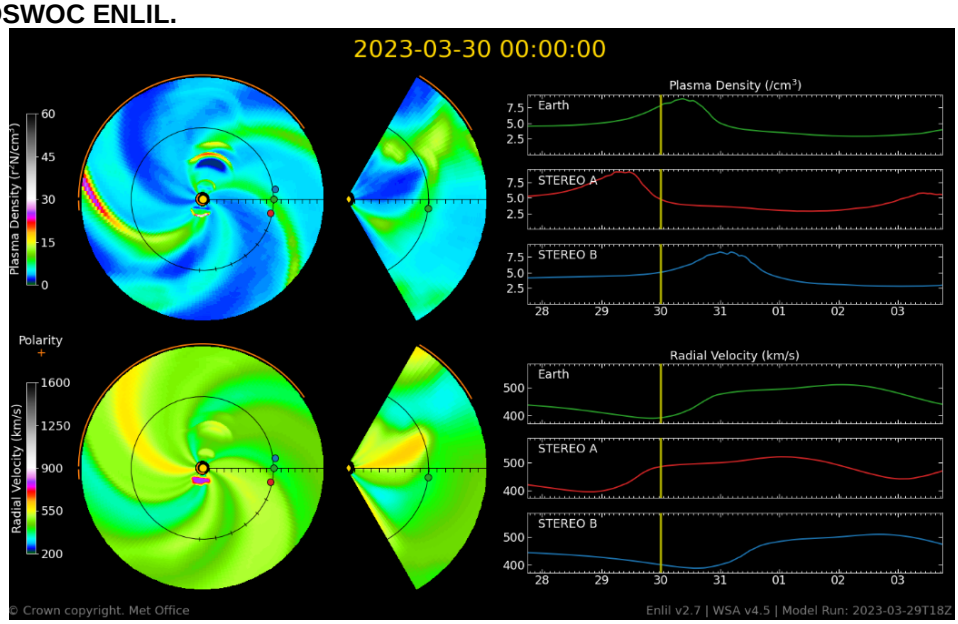
Several CMEs have been observed in the past 24 hours, though all appear to to either off the western limb or off the eastern limb and non are expected to have any Earth-directed element.

Solar winds are currently at slightly elevated levels. The next coronal hole expected to impact Earth is CH88/-. This appears slightly further west than the previous rotation so it's possible we may see its HSS and possibly CIR late on day 1 (30th), before entering into the HSS on day 2 (31st), with speeds likely to reach up to 500-550km/s. Solar wind speeds will then likely return back to slightly elevated or slow-ambient by day 4 (2nd).

Geomagnetic activity is expected to be mainly Quiet (Kp 0-2) initially, rising to Unsettled (Kp 3) with Active (Kp 4) intervals and a chance of G1/Minor or G2/Moderate storms upon the arrival of the HSS of CH88/- from later on day 1 (30th March), lasting until day 3 (1st April). Geomagnetic activity will likely return back to Quiet to Unsettled (Kp 0-3) later on day 3 or by day 4 (April 1st-2nd).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	40	30	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC ENLIL.



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Radio Blackouts - X-Ray Flares:

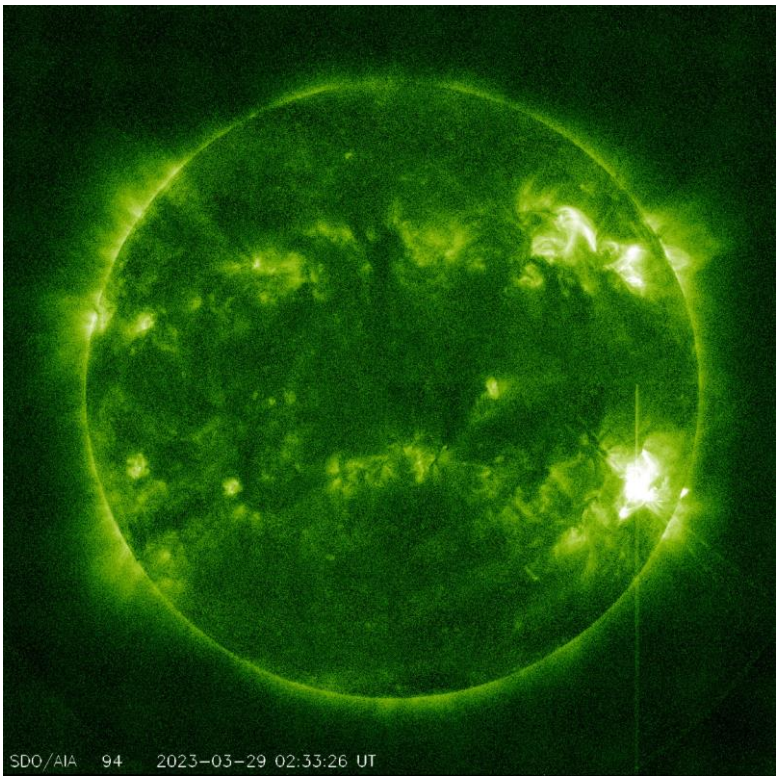
Solar activity has reached High levels over the past 24 hours, following an X1.2 flare at 29/0233UTC, an M1.8 flare at 29/1406 UTC and a M1.1 flare at 29/2346 UTC all from AR3256.

There are currently seven numbered and five unnumbered sunspot regions on the visible disc. AR3256 in the southwest remains the largest and most magnetically complex region, although showing continued signs of decay in its trailer portion. AR3263 and AR3265, both located in the northwest quadrant, are also showing some minor decay within their intermediate spot regions. A new region in the northeast of the disk is the only region showing signs of growth, currently analysed as a Cro/beta. The other active regions appear stable and magnetically simple, with only minor fluctuations in areal extent, with most showing signs of decay in areal extent.

There remains a Chance of further isolated M-class flares, most likely from AR3256.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	30	30	30	30
Very Active	R3 to R5 X Class	Yes	5	5	1	1

Figure 3: SDO 94 imagery showing X1 flare from 29th.



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES16 is currently at Background levels.

Proton flux is most likely to remain at Background levels, with a slight chance of reaching S1 or greater should any larger flares or significant CMEs occur, mainly from AR3256. As this spot rotates off the disk in the next 48 hours, the risk is expected to decrease further.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux has been at mostly High levels and is likely to continue at moderate to high levels through days 1 and possibly early day 2 (30th and 31st). The anticipated HSS arrival from CH88/- is then likely to re-distribute electrons, with a reduction in electron flux levels expected.

The 24-hour integrated electron fluence has now risen above the Active threshold and is expected to continue at Active levels through day 1 (30th) and perhaps into early day 2 (31st). However, as described above this should then reduce into day 2 until day 4 (March 31st until 2nd April) as Earth enters the High Speed Stream (HSS) from CH88/-. REFM trends are considered reasonable from day 3 onward (1st-2nd April), but are likely underplaying values through the first half of the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	60	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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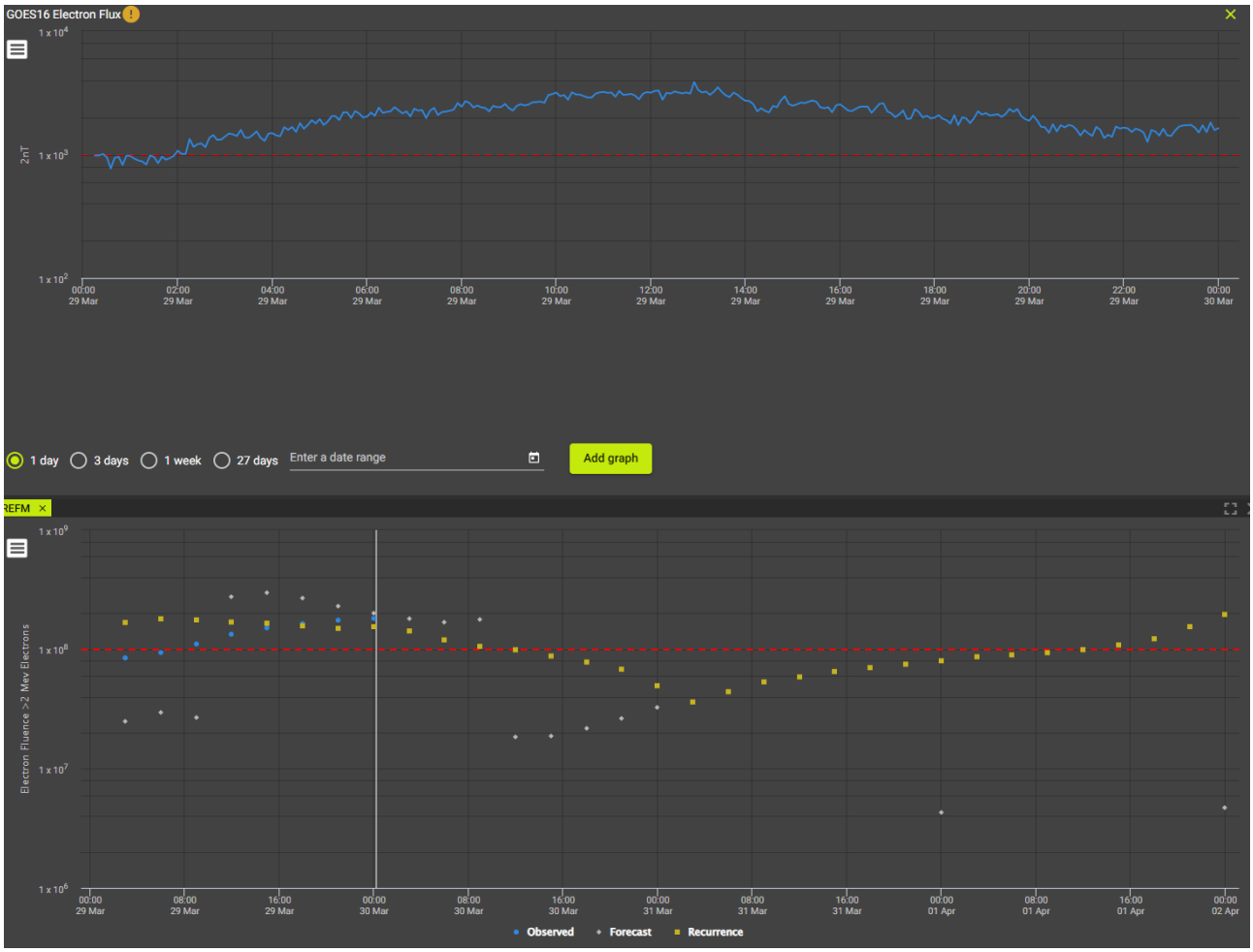
Figure 4: Electron flux trace past 24 hours & fluence obervations, forecast and recurrance.



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